# Guide to the AAAS Federal R&D Budget Dashboard

*May 2018*

The AAAS Federal R&D Budget Dashboard is an interactive tool for exploring long-term funding trends within the context of the broader budget. The dashboard allows users to examine federal R&D spending data by agency and/or by character of work over multiple decades in total dollars, as a share of the budget, and as a share of the U.S. economy. Additional data on other U.S. R&D funding sources at the national scale, including businesses and universities, has also been added.

**To download data from the dashboard:** Select the data you want to grab in the visualization pane – either by clicking and highlighting a specific time series, or by clicking-and-dragging to highlight and select multiple series and/or data points – and click the "download" button on the bottom right; you can then choose to download your selected data, or a complete crosstab.

**Where does the data come from?** At the start of each year, federal agencies are required to tally and report detailed expenditures on research and development (R&D) to the White House Office of Management and Budget (OMB), as outlined in OMB Circular A-11, which guides federal budget preparation. Since 1976, AAAS has gathered and compiled this data to assemble as complete a picture of government-wide R&D spending as possible. In addition, some current and historical data is published by OMB and the Office of Science and Technology Policy (OSTP) as part of the President's annual budget submissions to Congress, and certain agencies – like the National Science Foundation and the Department of Energy – also typically include their data within their own budget submissions. Data on U.S. R&D expenditures by funding source comes from NSF's National Patterns of R&D Resources series.

Individual agency data and functional outlay data was last updated by AAAS in **May 2018.** Data on R&D by funding source was last updated in **September 2017**.

## NAVIGATING THE DASHBOARD: SOME BASIC CONCEPTS

The current dashboard is composed of five interactive tabs. The first focuses on R&D budget authority by agency and by character of work, in total dollars, from fiscal year (FY) 1976 to FY 2018 (the federal fiscal year runs from October 1 to September 30). The second uses the same data set, but presents R&D budget authority as a share of the total federal budget and the economy (U.S. GDP). Both of these tabs

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are based on a mix of OMB and agency reporting over the years, supplemented with NSF survey data in certain instances where other data was missing.

The third tab comes from a different source: [historical tables updated annually by OMB](#) as part of the President's budget request. This data set goes back to FY 1962.

The fourth and fifth tabs draw on data from the [National Patterns of R&D Resources](#) series published annually by NCSES. This set goes back to 1953.

A key difference between these tabs is the metric they use. The first two tabs rely primarily on **budget authority,** while the third tab relies on **outlays.** Both metrics are common in budget discussions and decision-making, but they mean different things and serve different purposes.

**Budget authority** is the legal authorization to expend funds (also known as the power to incur obligations by signing a contract, issuing a research grant, or paying employee salaries). When Congress grants an appropriation to an agency, it is providing budget authority: the permission to go ahead and spend a certain amount of taxpayer dollars. Budget authority typically applies to a single fiscal year, though it can be moved between years in some instances. For example, if a science program is given $100 million to spend in FY 2009, but it only spends $95 million, it may have the legal ability to carry the remaining balance forward to use in FY 2010 (though not always!). AAAS has traditionally used budget authority as the preferred metric to monitor spending because that is what Congressional decision-making is based upon during appropriations, and hence that is what the first two tabs primarily use.

**Outlays** represent checks issued and cash payments made during a given period, regardless of when the funds were appropriated or obligated. This is the metric to use when attempting to understand the actual federal cash flow. Tab 3 uses outlays because that is how the source data is presented by OMB.

Since they measure different things, there is often a lag between budget authority and outlays. For a hypothetical example: NASA is granted *budget authority* by Congress to build a new lab starting in FY 2010. The construction process begins in FY 2010, but is not completed until FY 2012. NASA thus makes *outlays* as contractor payments into FY 2012. For another example, the American Recovery and Reinvestment Act, which provided a one-time boost to R&D expenditures, was signed into law in 2009. This extra *budget authority* went on the books entirely in FY 2009 (and is readily visible in dashboard tab 1), but the resulting *outlays* continued into FY 2010 and beyond (and are somewhat visible in dashboard tab 3).

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Also note that for three agencies in the first two tabs – specifically NOAA, NIST, and USGS – the historical AAAS-compiled data has been supplemented with data from the [NCSES Federal Funds for R&D survey](link), as described in the agency section below. This was done to remedy instances of missing data. The NCSES survey series uses yet a third funding metric: **obligations**. Obligations refer to the actual commitment of funds, such as the decision to official award a grant or contract. Obligations come between budget authority (when Congress gives an agency the power to fund projects) and outlays (when an agency actually cuts the check). While obligations and budget authority measure different things, in reality the differences between the two are often fairly small.

Beyond time span covered and spending metric used, the three tabs also have some significant differences in variables they display. These differences will be explained in the following sections.

## TABS 1 AND 2: R&D BY AGENCY AND CHARACTER

The first two tabs both allow the user to select funding years, agencies, and character of work. Because they rely on the same underlying data set, most material in this section applies to both.

- ***R&D by Character***

As part of agencies' annual R&D reporting to OMB, they classify their funding activities by character, or type, of R&D. These classifications are based on definitions established by OMB in their A-11 circular mentioned above. Agencies do the best they can to classify their R&D activities, but such accounting may not always be perfectly consistent from agency to agency. The current dashboard allows the user to select among four options. The definitions are as follows:

**Basic Research:** Activities to gain knowledge or understanding of physical phenomena without specific applications in mind. This represents the most fundamental, blue-sky science.

**Applied research**: Activities to gain knowledge or understanding necessary for meeting a specific need.

**Total Research:** Simply the sum of the above two classes of R&D.

**Total R&D:** The sum of total research, plus two more R&D classes not currently broken out in the dashboard: *development* and *R&D facilities.* Development refers to the systematic use of knowledge for technology: the production of materials, devices, systems, or methods, including design, development, and improvement of prototypes and new processes. R&D facilities include construction, repair, or

alteration of physical facilities used during R&D, as well as major capital equipment. A future version of the dashboard will provide the option to select these choices.

- *Agencies*

Eleven options are available for agency selection.

**DOD:** Department of Defense.
**DOE:** Department of Energy, including the Office of Science, the National Nuclear Security Administration, and multiple technology offices.
**NASA:** National Aeronautics and Space Administration.
**NSF:** National Science Foundation
**NIH:** National Institutes of Health
**USDA:** Department of Agriculture, including intramural and extramural research, and the Forest Service.
**USGS:** U.S. Geological Survey. Data up to FY 1997 is from the NCSES Federal Funds Survey.
**NIST:** National Institute of Standards and Technology. Data up to FY 2004 is from the NCSES Federal Funds Survey.
**NOAA:** National Oceanic and Atmospheric Administration. Data up to FY 2004 is from the NCSES Federal Funds Survey.
**All Other:** R&D funded by other agencies. Major funders include the departments of Homeland Security, Transportation, and Veterans Affairs, as well as the Environmental Protection Agency (EPA).
**Recovery Act:** Tab 1 also allows the user to view total Recovery Act funding. As mentioned above, the Recovery Act was signed into law in early 2009, as a countercyclical measure in response to the recession. That legislation included slightly more than $18 billion in nominal dollars (or more than $20 billion in 2016 dollars) for R&D. About half of this funding went to NIH; the rest was scattered among several other agencies, with major portions going to DOE and NSF.

- *Other Notes*

Tab 1 also allows the user to switch between nominal dollars and constant (inflation-adjusted dollars). Constant-dollar figures were calculated using OMB's chained GDP price index, with 2018 as the base year. Nominal dollars are converted to constant dollars by dividing the nominal figure from each year with its corresponding deflator.

Tab 2 uses the same data set, but makes two adjustments to place R&D spending in fiscal and economic context.

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First, all spending figures are divided by **total federal budget authority** for each year, to demonstrate the portion of all federal expenditures devoted to each agency's R&D activities over time. This total is available in OMB's historical data table 5.1. In the dashboard, R&D as a share of the federal budget is displayed as dots, and corresponds with the left Y-axis.

Second, spending figures are also divided by **U.S. gross domestic product** (GDP), to demonstrate agency R&D relative to the size of the national economy over time. GDP data was taken from OMB historical table 10.1. In the dashboard, R&D as a share of the economy is displayed as lines, and corresponds with the right Y-axis.

Tab 2 does not include the constant/nominal dollar toggle, as the graphs would appear the same either way.

## TAB 3: THE FEDERAL BUDGET OVERALL

As mentioned above, tab 3 relies on a different metric from a different source – OMB historical data tables – and so offers some different options than the prior tabs, starting with the fact that the data series extends further into the past, to 1962.

The goal of this tab is to provide a look at the federal budget overall, with an alternate view of federal R&D situated within it. The user can toggle between the straightforward composition of the budget (involving 100% of all spending), and the composition of the budget relative to U.S. GDP, using the OMB GDP data mentioned above.

- *Spending Categories*

As seen in the link to the OMB website linked above, OMB provides a large array of time series on federal expenditures, slicing the data in many different ways. AAAS has combined different slices of this data at different scales and aggregations to assemble the picture seen in tab 3, including R&D by budget function. A description of each spending category follows.

**Net Interest.** Interest payments on the federal debt, taken from OMB historical table 8.1.

**Mandatory Outlays.** "Mandatory spending" is one of the major categories of federal budget expenditures, along with "discretionary spending" and net interest (OMB table 8.1). Mandatory

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spending is spending that does not go through the regular appropriations process, and is instead governed by other legislation. This category is dominated by the few large entitlement programs – Medicaid, Medicare, and Social Security – though it also contains other smaller programs like veterans benefits, many Farm Bill programs, and other assorted income security payments. Most, but not all, spending in this category is essentially on "autopilot" (in contrast with discretionary spending, which is adjusted annually by the budget and appropriations committees). Note that some spending in the investment categories in this section (R&D, training, infrastructure) is classified as mandatory, and so there may be some small overlap.

**Defense Outlays (non-R&D).** This is all discretionary spending that falls into the "national defense" budget function, *minus* defense-related outlays for R&D, which appear separately in the dashboard. It is primarily constituted by the Department of Defense, though it also includes the National Nuclear Security Administration, and some other small components of other agencies (OMB table 8.1).

It's worth taking a moment to understand the term **budget function**, as it will come up again. "Budget functions" are simply topical groupings used by OMB to categorize spending. There are twenty budget functions in all, covering all areas of government. They essentially allow one to see where federal dollars are flowing by focus area. The "Defense Outlays (non-R&D)" spending category is simply all spending in the national defense function.

**Education and Training** and **Infrastructure (nondefense)**. There are three higher-level budget categorizations that OMB has dubbed investments, which cut across multiple budget functions (OMB tables 9.1 – 9.9). The first two are Education and Training, and Infrastructure (the third is R&D, broken out below). Education and Training includes direct federal spending for training programs and education activities (including elementary and secondary schools and higher education) as well as state and local grants. For this dashboard, infrastructure excludes defense-related infrastructure, which appears in the Defense Outlays category. It includes direct federal spending and local grants for highways, airports, bridges, railroads, pollution control facilities, and other infrastructure spending, as well as funding for the Army Corps of Engineers, the Tennessee Valley Authority, and similar programs.

**All Other Outlays.** This category simply captures all other spending not included elsewhere in the dashboard: generally, nondefense discretionary spending not classified as R&D, education and training, or infrastructure.

- *R&D Functions*

As mentioned above, the federal budget is divided into twenty individual functions, each representing all federal programs that deal with a roughly common topic or focus. Every federal program or budget account resides in a budget function somewhere. Like most other categories in tab 3, R&D spending cuts across multiple functions. Unlike the other categories, however, federal R&D outlays are shown in the dashboard at the more detailed functional level (it *is* an R&D budget dashboard, after all). A recap of each function follows.

**Defense:** This contains all R&D funded by the Department of Defense and the National Nuclear Security Administration (and some other smaller accounts at other agencies).

**Energy:** This refers primarily to R&D funded through the Department of Energy's applied technology offices dealing with nuclear, fossil, renewables, and efficiency, and the Advanced Research Projects Agency-Energy (ARPA-E).

**General Science:** This includes the National Science Foundation and the Office of Science within the Department of Energy.

**Health:** This function is dominated by the National Institutes of Health, but also includes other R&D spending by, for instance, the Centers for Disease Control and Prevention and the Agency for Healthcare Research and Quality.

**Space:** This category is constituted by NASA, *except* NASA's Aeronautics directorate, which is classified in the Transportation function.

**Ag and Environment:** This actually represents two combined functions: Agriculture and Natural Resources and Environment. There are several departments and agencies included here, among them the departments of Agriculture and Interior; the Environmental Protection Agency; and the National Oceanic and Atmospheric Administration.

**Transportation:** This includes the Department of Transportation and NASA's Aeronautics directorate.

**Other Functions:** Other significant contributors include the veterans function (Department of Veterans Affairs); the justice function (mostly the Department of Homeland Security); and the commerce function (the National Institute of Standards and Technology, among others).

**TABS 4 AND 5: R&D BY FUNDING SOURCE**

Tabs 4 and 5 draw on data from NSF's National Patterns of R&D Resources annual series, which is based on NSF's extensive surveys on overall R&D spending trends in the United States going back to 1953; note that this data is presented by *calendar year*, and not fiscal year.

Both tabs offer a look at the principal funding sources across the U.S. R&D system.  This includes:

**Industry:** Includes the own funds of domestic R&D performing businesses, funds from other domestic businesses, and funds from foreign businesses.
**Federal government:** Funding from federal agencies.
**Universities:** Includes academia's own institutional funds.
**All Others:** Includes funding from nonfederal government (state and local), nonprofit organizations, and other sources.

Tab 4 breaks down these funding sources by character, or type, of R&D. This includes (1) basic research; (2) applied research; (3) total research; (4) development; and (5) total R&D. For a description of each, see the "R&D by Character" section on page 3.

Tab 4 also allows the user to switch between nominal dollars and constant (inflation-adjusted dollars). Constant-dollar figures were calculated based on Bureau of Economic Analysis (BEA) implicit price deflators for GDP, with 2017 as the base year. Nominal dollars are converted to constant dollars by dividing the nominal figure from each year with its corresponding deflator.

Tab 5 uses the same data set, but presents R&D funding sources as a share of **U.S. gross domestic product** (GDP), to show funding changes relative to the national economy over time. GDP data was taken from BEA table 1.1.5.

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